

Description of Quadrangle 6 topography excerpted from:

Valentine, P.C., Unger, T.S., and Baker, J.L., 1999, Sun-illuminated sea floor topography of Quadrangle 6 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2706, scale 1:25,000.

Introduction

The Stellwagen Bank National Marine Sanctuary Mapping Project is a cooperative effort of the U.S. Geological Survey and the National Oceanic and Atmospheric Administration, with support from the University of New Brunswick and the Canadian Hydrographic Service. The multibeam echo sounder survey was conducted on four cruises over a two-year period from the fall of 1994 to the fall of 1996. This map shows one of a series of 18 quadrangles (see location map) in which sea floor depth information is depicted in sun-illuminated (or shaded relief) view at a scale of 1:25,000, with topographic contours overprinted in blue. The image shown here uses a sun elevation angle of 45 degrees above the horizon from an azimuth of 350 degrees and a vertical exaggeration of four times. In effect, topographic relief is enhanced by having the sun illuminate the sea floor from a position 10 degrees west of north, so that shadows are cast on the southern flanks of seabed features. Some features in the images are artifacts of data collection. They are especially noticeable where the seabed is smooth, and they include small highs and lows and unnatural-looking features and patterns that are oriented parallel or perpendicular to survey tracklines. For a depiction of the topographic contours alone, and for an explanation of survey and topographic data-processing methods, see the companion map by Valentine and others (1997). Topographic contour maps of all 18 quadrangles in the map series are available on a CD-ROM in EPS, PS, Arc export, and PDF file formats (Valentine and others, 1998). Blank areas represent places where no data exists.

Regional seabed features

The major topographic features depicted in the map series were formed by glacial processes. In broad terms, these features are interpreted here to represent a geologic history that developed in several stages. Ice containing rock debris moved across the region, sculpting its surface and depositing sediment to form the large basins, banks, ridges, and valleys. Many other features observed here represent the latter stages of deglaciation. They are the result of processes at work when much of the area was covered by stationary rotting ice, and when at the same time small valley glaciers and ice falls were active in and near areas of high topographic relief. The sea invaded the region formerly occupied by ice, and seabed features were partly eroded and some new sedimentary deposits formed. Today, the sea floor is modified mainly by strong southwestward-flowing bottom currents caused by storm winds from the northeast. These currents erode sediments from the shallow banks and transport them into the basins. With time, the banks affected by these currents become coarser, as sand and mud are removed and gravel remains; and the western flanks of the banks, as well as adjacent basins, are built up by deposits of mud and sand.

Quadrangle 6 features

This quadrangle covers the eastern central part of Stellwagen Bank and several banks that lie to the east. The surface of Stellwagen Bank slopes gently eastward through water depths of 35 to 75 m and is covered with sand and gravel. In the 50- to 75-meter interval, the surface is very

rough due to the presence of large shallow depressions and boulder piles and ridges. Many of the boulder ridges resemble eskers (sand and gravel deposited by running water within stationary glacial ice). The ridges commonly are constructed of boulders and cobbles that are now separated by voids from which sand and small gravel presumably were eroded during advance of the sea after the glacial ice melted. The shallow depressions in the sea floor (for example, at 42° 16.8' N., 70° 09.3' W.) possibly outline the former locations of large masses of melting glacial ice.

The bank's eastern margin, between approximately 75 and 100 m water depth, is formed by the walls and heads of valleys that extend into deeper water to the east. In the north-central part of the quadrangle, the Stellwagen Bank edge is capped by a linear north-trending sand bank that extends into Quadrangle 9 (Valentine and others, 1999b). The sand bank lies in water depths of 70 to 75 m. Its surface is dissected by shallow southeast-trending gullies and also is characterized by several arcuate ridges as high as 5 m that display bedforms on their surfaces.

Three prominent flat-topped banks (North Ninety Bank, East Ninety Bank, Middle Ninety Bank) lie at depths of 90 to 95 m in the eastern part of the quadrangle. The bank tops are sandy and gravelly and display shallow depressions and boulder ridges that are similar to features on Stellwagen Bank described above. The northern part of a fourth 90-meter-deep bank (South Ninety Bank) lies at the southeastern edge of the quadrangle and extends southward into Quadrangle 3 (Valentine and others, 1999a). It is less well formed than the others, and its surface of sand and gravel is less rough.

The banks are separated from Stellwagen Bank and from each other by smooth-floored valleys that appear to have been deepened by the movement of small glaciers. The valley floors are muddy sand. The valley walls exhibit narrow ridges (42° 16.0' N., 70° 04.3' W. and 42° 18.8' N., 70° 06.3' W.) that parallel topography and are interpreted to be lateral moraines (deposits of rock debris piled up at the edges of moving ice) now covered by muddy sand. A rough-surfaced lobate feature of low relief extends from the base of the southern flank of the easternmost bank (42° 15.7' N.). It is interpreted to be rock debris deposited from an ice fall that flowed from the top of the bank and spread out on the valley floor below. It retains its distinctive shape beneath a thin layer of muddy sand. A feature of similar origin lies across the valley at the base of the opposing bank to the south (42° 15.1' N.). Hummocky topography in the northeast corner of the quadrangle represents the eroded western flank of another 90-meter-deep bank whose summit lies 800 m east of the quadrangle boundary.

REFERENCES CITED

- Valentine, P.C., Unger, T.S., Baker, J.L., and Roworth, E.T., 1997, Sea floor topography of Quadrangle 6 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Open-File Report 97-507, scale 1:25,000.
- Valentine, P.C., Baker, J.L., Unger, T.S., and Polloni, C., 1998, Sea floor topographic map and perspective-view imagery of Quadrangles 1-18, Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Open-File Report 98-138, 1 CD-ROM.
- Valentine, P.C., Baker, J.L., and Unger, T.S., 1999a, Sun-illuminated sea floor topography of Quadrangle 3 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2703, scale 1:25,000.

——1999b, Sun-illuminated sea floor topography of Quadrangle 9 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Geologic Investigations Series Map I-2709, scale 1:25,000.